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ABSTRACT

This paper discusses the impact of computers on student learning as reported by teachers participating in a study of a computer-based language arts instructional program for the early elementary grades--the Apple Learning Series: Early Language (ALS-EL). Although they found the program difficult to evaluate, some teachers stated that the ALS-EL program had a positive impact on student writing but less impact on student reading skills. Few teachers attributed higher-level reading fluency or comprehension benefits to ALS-EL use, although most of them felt the students were gaining important computer competencies. They also reported that non-literacy outcomes such as enhanced student self-esteem, attitudes toward school, cooperative behavior, and motivation, all appeared to be positively influenced by use of the ALS-EL program. It is concluded that, although this study indicates that ALS-EL can function as a catalyst for change, contributing to the successful transformation of the learning environment, promoting creative teaching techniques, and influencing student achievement, such outcomes must be viewed cautiously given the short-term nature of the study. (21 references) (DB)

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THE IMPACT OF COMPUTERS IN PRIMARY GRADES

by

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STUDENT AND TEACHER SUCCESS: THE IMPACT OF COMPUTERS IN PRIMARY GRADES

Nancy Gadzuk Drexler, Glen Harvey, and Diane Kell*

Increasingly educators, policymakers, and community members are asking for evidence that the investment of often scarce resources in technology has yielded positive results. In what ways has student learning been positively affected? Is student achievement increasing as a direct consequence of the use of computers? Are teachers using more effective instructional strategies? Has the classroom learning environment changed to better meet the diverse needs of students? The purpose of this paper is to begin to address these questions, drawing on our findings from the Computers and Literacy Development in Primary Classrooms Project.

In 1988-89, The Regional Laboratory for Educational Improvement of the Northeast and Islands was funded to conduct a study to assess the effectiveness of the Apple Learning Series: Early Language (ALS-EL), a computer-based language arts instructional program for the primary level.[1] In this paper we explore literacy-related outcomes for students in the areas of reading, writing, and computer competency as well as non-literacy outcomes such as increased self-esteem, student motivation, positive attitudes toward school, and alternative success experiences. The paper also examines the relationship between computer-based innovations and teacher change -- in attitudes, motivation, classroom management, teaching techniques, etc.

Research on new program implementation and planned change in schools, including our own experience, tells us that after one year of implementation, it is much too soon to expect measurable student impact from the Early Language program. Nonetheless, our preliminary

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[1]Over 1,000 students, 57 teachers, 62 classes, and 12 schools were involved in the study during the 1988-89 school year. A total of 48 kindergartens, first and second grades, and special program classrooms all using ALS-EL were involved; 14 kindergartens and first and second grades served as comparisons. The schools were geographically dispersed in the western, midwestern, and southern parts of the United States.

findings serve to confirm prior research and provide roadmaps or blueprints for more extensive examination of the impact of computers in the primary classroom.

Variations in Use of ALS-EL

ALS-EL was designed with a variety of components to be used flexibly and in a broad array of classroom settings, rather than in a rigid, lockstep fashion. The software components included in ALS-EL represent different approaches to early language development. Some provide practice in letter, number, shape, and color recognition; matching of upper- and lower-case letters; the concept of one-to-one correspondence; and consonant and vowel identification (Muppets on Stage, Muppetville, Muppet Word Book). Some make use of electronic voice synthesizers to help students develop symbol/sound correspondence and word attack skills (Sound Ideas: Vowels, Consonants, and Word Attack). Some allow children to communicate with graphics and to explore combinations of graphics, letters, and words (ColorMe, Where Did My Toothbrush Go?). Some are tools that children can use to express their ideas in writing, see their own words in print, and share them with others (Talking Text Writer and the writing slate in the Muppet Word Book); One (Talking Text Writer) also includes a sound component allowing children to hear the letters, words, sentences, or whole texts that they have written. One provides practice in letter formation (Touch 'N Write). The accompanying Teacher's Manual developed by Apple provides sample layouts of how computer stations can be incorporated into a variety of classroom designs as well as sample lesson plans and strategies for curriculum integration.

We anticipated that we might find variations in use of ALS-EL and therefore impact associated with differences in teachers' theoretical orientations to language arts. In both October 1988 and May 1989, we asked teachers to complete the DeFord Theoretical Orientation to Reading Profile, or TORP (DeFord, 1985). The TORP instrument asks teachers to respond to statements of belief about practices in reading instruction indicating, on a scale of 1 to 5, how strongly they agree or disagree with the statement. The resulting score indicates where a teacher's belief system falls upon a continuum of approaches to reading instruction, from phonics to skills to whole language. The scores of the teachers in our study were quite stable from the beginning to the end of the year, with close to two-thirds of the teachers falling within the range describing a skills orientation and about three-tenths falling within the range describing a whole language orientation. Only three teachers, all from the same site, had scores indicating a phonics orientation.

Depending on their approaches to both literacy development and classroom instruction, teachers chose to use different pieces of software, or use the same piece of software differently. For example, a whole language teacher might use Talking Text Writer, a word processing program with an aural component, with students to create and revise their own

original texts. A teacher using a phonics approach might use Talking Text Writer with word lists to help students identify beginning consonant sounds. A phonics-oriented teacher might not use Where Did My Toothbrush Go? because it does not emphasize decoding, whereas a whole language teacher might use it because of its emphasis on thinking and comprehension.

To assess the impact of computers in the classroom, we needed a measure that captured differences in the degree to which teachers made knowledgeable and effective use of ALS-EL in their classrooms. We developed a measure based on researchers' ratings of these five indicators of implementation quality:

- uses a variety of ALS-EL software components;
- actively plans for curriculum integration;
- is familiar with all progams and makes knowledgeable choices;
- uses with all students, or varies use for good instructional reasons; and
- makes full or appropriate use of the hardware and peripherals, including sound synthesizer and printer.

Overall, 37 percent of participating teachers were rated as high implementers; 23 percent, medium-high; 23 percent, medium-low; and 16 percent, low. These ratings were highly correlated with the teachers' self-perceptions of their levels of expertise with computers and with ALS-EL.

ALS-EL use in the classrooms of our study could vary tremendously. Teachers could elect which software components to use for any instructional (or non-instructional) reason; students could have differential access to various ALS-EL programs; ALS-EL could be integrated into the overall curriculum at varying levels. There was no single "treatment" called ALS-EL that all teachers followed and which could easily be compared across students or classes. Because of this, it is particularly worthwhile to examine how teachers representing diverse viewpoints and instructional environments have responded to ALS-EL as an instructional tool and how they perceived student literacy outcomes.

Teacher Perceptions of Student Literacy Outcomes

Many teachers, regardless of approach, found it difficult to evaluate the effects of ALS-EL apart from the effects of their overall language arts programs. This teacher statement sums up their difficulty: *"There are changes in all those things [reading, writing, verbal development], but I don't know whether they are related to the computers."* Nevertheless, there were also many comments indicating that the majority of teachers valued one or more ALS-EL components very highly as tools for developing or reinforcing student achievement in the language arts. In the following section, we discuss teachers' perceptions of student outcomes in writing, reading, higher level cognitive skills, and computer literacy development. We also discuss teacher perceptions of the value of the medium of the computer itself for student learning.[2]

Perceived Impact on Student Writing

Some teachers were convinced that ALS-EL had a positive impact on their students' development as writers. This was especially true where Talking Text Writer had become an important medium for writing in classrooms in which the writing process was emphasized. As one teacher said,

> *I see students view themselves as real authors. . . . They write stories. . . . They publish their stories. . . . Other students read their stories that they publish in the classroom. . . . They view themselves as a community of readers and writers. . . . There is a great deal of finished work.*

Teachers who thought their students were writing more on the computer included both kindergarten and first grade teachers, and they were primarily high or medium-high implementers. Several low or medium-low implementers said they could see little or no improvement in student writing resulting from students' use of the computers.

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[2]In addition to teacher perceptions and our observations, we used the Sulzby Writing and Rereading Task and the Test of Early Reading Ability (TERA) as objective means of measuring children's literacy development. (For details on the Sulzby method of eliciting writing from children, see Sulzby, Barnhart, & Hieshima, in press; and Sulzby, 1988. For details on the TERA, see Reid, Hresko, & Hammill, 1981) We used these instruments in project classes and, in three sites, in comparison classes not using ALS-EL, in both the fall of 1988 and the spring of 1989. As anticipated, we saw few differences based on these measures. Children in project and comparison classes performed similarly in both the fall and the spring.

A few teachers believed that Talking Text Writer, in particular, helped their students understand the *"concept of words"* and the relationship between spoken language and printed text. This print awareness enabled many of their students to move into the arena of writing more quickly than they would have without it, they felt.

We were interested in evidence of editing and revising while writing at the computer. In general, there was little evidence at the kindergarten level of much revising, other than an occasional attempt to correct individual words. At the first grade level, teachers in several high implementing classrooms found that their students were beginning to revise and edit at the computer. According to one of these teachers:

> *They feel freer about writing when they don't have to erase and see all this dirty paper -- just because I made a mistake, and my paper is going to look all dirty, so I'll tear it up.*

One of our sites was a Chapter 1 site that included older students -- through the fifth grade. Here, a great deal of editing and revising occurred at the computers. One teacher at this site observed:

> *It is much easier for the kids to edit and revise on the computer, and this is one reason we like [Talking Text Writer] for our kids. They have trouble with writing and reading in the regular classroom, and this gives them a different -- and easier -- way to deal with writing and reading.*

Perceived Impact on Student Reading

While many teachers did cite some reading improvements, they were generally less exuberant in discussing these impacts than they were about improvements in writing. There were exceptions, however: teachers who emphasized phonics and word attack skills in their overall language arts approach tended towards more exuberance in describing ALS-EL's impact in these areas. One first grade teacher with a relatively strong phonics orientation was emphatic in her assessment of the children's improved reading abilities, even though we judged her to be a medium-low implementer overall:

> *Well, this is my first time using computers, and I've had faster children than these, and I think because of the computers, they know more words, they know more sounds, they know more word parts. . . . That story that comes on [in Sound Ideas: Word Attack] is a good example. They are able to read all those stories now, on their own, right along with the man [in the story]. They know all the words. I would have to say, because of these computers, this class has gone faster than any class I've had.*

Teachers representing all orientations to reading and all levels of implementation speculated that ALS-EL could contribute to developing basic skills in reading, especially as a reinforcement or extension of regular classroom activity. They particularly mentioned such skill components as letter recognition (kindergarten), letter-sound correspondence (kindergarten and grade one), and phonics-based word analysis for reinforcing skills already developed in the classroom; relatively few teachers described the computers as an important medium for introducing or advancing children's skill development.

Perceived Impact on Higher Level Skills

Relatively few teachers attributed higher-level reading fluency or comprehension benefits to ALS-EL use. Two teachers mentioned improved understanding of story line development, or story analysis, as an outcome. Only four teachers referred to higher level cognitive gains as possible outcomes of the program. Two teachers mentioned that children needed to use logic to find the toothbrush in Where Did My Toothbrush Go?

While few teachers asserted benefits in terms of higher level thinking skills, our field researchers witnessed a number of episodes in which teachers were helping students to develop thinking and learning strategies. These were seen most frequently in classrooms with high-implementing teachers. In one first grade classroom where the teacher was integrating science education with writing, we heard her tell her students:

> *When I was walking around, I heard you say exactly the kinds of things scientists in a laboratory would say. You're looking. . . you're making connections, you're asking questions.*

Later she asked them to write entries into a learning log, and reminded them that it can be difficult to write.

> *I've talked about a lot of brain work. It's hard to do a good learning log entry because you have to be patient. When you start your entry, you may think, "I don't have anything to say." Wait it through. Let your ideas come.*

Although few teachers mentioned higher level thinking skills, a number did mention problem solving and creativity as potential benefits of ALS-EL use. Some of this problem solving was related to work with computers. While we observed many instances of students solving problems at the computers, we also observed that not all students were adept at solving problems creatively without teacher assistance.

Perceived Impact on Computer Skills and Attitudes

The overwhelming majority of teachers felt that their students were gaining important computer competencies, even though we continued to see varying levels of independent use in our observations. When teachers provided ample direction, or allowed students to experiment and teach each other, independent use of the computers soared. A first grade teacher, reflecting on her experiences, said, *"Once I stopped being scared about letting them touch the software, the better off they were. I would recommend keeping that idea alive. . . . Kids can handle it."* Only two teachers, both low implementers, felt their students were not interested in computers or would break them.

Change in the Medium of Instruction

The medium of the computer itself, different from paper and pencil, was very important for some children. Teachers pointed out several features of the computer that helped their students, primarily the various modalities aided by the sound feature and the print feature. According to one kindergarten teacher, *"You're teaching to a lot more senses."* One HILT (high intensity language training) teacher felt that for her limited English proficient learners, hearing what they were writing was both motivating and reinforcing, and aided them in learning English. Many teachers liked the immediate reinforcement that the computer offered, along with its patient, non-judgmental feedback.

One administrator talked about the power the Talking Text Writer can have:

> *It releases kids in lots of different ways. It releases kids who are not at breakthrough, or who have not broken code. It releases them to put some kind of script on the computer when they're not at that point. It helps kids who are at the composing stage, to be able to draft and get their ideas down, and for many children, just tracking the cursor. . . is very beneficial.*

She further noted how the medium can have a distancing effect that takes some of the risk away for certain children:

> *The child, the writer, becomes detached. That really helps some children. Because when you're talking about writing, and it's very personal, which writing is, and a child is hesitant about being a part of a discussion about whatever they've written -- when it's up on the screen, somehow or another it doesn't belong any more to that person. And it's easier to discuss because it's now on a machine, and it kind of loses that emotional stance. And I've seen it work really well for some kids.*

Some teachers, however, felt that some students, particularly more able students, were not helped by using the computer. *"His hands can't use the keyboard as fast as they need to get what he has in his mind out."* Most teacher concerns indicating less benefit for more able students referred to their use of Talking Text Writer and involved students and classrooms where there was relatively little revision occurring in the students' writing.

A few teachers felt that their slower or more immature students were not able to benefit from the computers as much, or as quickly, as their more able classmates. Often, these students were unable to work independently at the computers and the teachers were unable to find the time to work with them to gain independence.

Tentative Conclusions Regarding Student Literacy Outcomes

Research and experience tell us that it is reasonable to expect little or no measurable difference in student literacy outcomes at this point of implementation, while many teachers are still struggling with basic management issues concerning their use of computers. We do believe, however, that the perceptions of participating teachers suggest a positive impact of ALS-EL when it is used effectively. Most importantly, we heard the following points from teachers:

- ALS-EL serves to reinforce student achievement in the language arts.
- ALS-EL (especially Talking Text Writer) has a positive impact on students' writing; teachers varied on the type of impact they identified, including: longer and better stories, better spelling, larger vocabulary, print awareness/concept of words, and/or editing/revising among older children (in our Chapter 1 site).
- ALS-EL contributes to the development of important computer competencies.

Teacher Perceptions of Non-Literacy Outcomes

Most educators would agree that enhanced student self-esteem, increased opportunities for success, positive attitudes toward school, cooperative learning behavior, and raised levels of personal motivation to learn are all critical characteristics of a healthy, productive learning environment. One of our intentions through this project was to better understand the relationship between computer use and non-literacy student outcomes.

Alternative Avenues for Success

The introduction of ALS-EL into the classroom opened a whole new array of opportunities for students to demonstrate competence and therefore achieve success. Such opportunities for success are particularly important because they may be associated with increased self-esteem and self-confidence, as well as potentially with more positive attitudes toward school in general and learning in particular.

Episodes of success are particularly important for students who seldom experience success in school (e.g., low-achieving students) as well as for students who may enter school with less than positive self-concepts. Although neither the computers nor the Early Language Series guarantee that all students will meet with success, there is evidence to suggest that students are experiencing success as they use the computers -- and that not only English proficient high achievers are having positive experiences. Spanish-speaking and limited English proficient students, for example, have been able to engage successfully with selected ALS-EL software programs.

We observed, for example:

> *The new Spanish-speaking student sat at the computer for a while and stared at it and then at the observer, who finally gave him a few simple directions in Spanish. He took off and with no more help began mastering the games on Muppetville. While working on "Zoo" it was evident that he didn't know all his numbers by sight. The observer showed him how to find the right number by counting on the screen and keyboard. He did this, got the right answer, and clapped his hands with glee. He really enjoyed his successes. He had the same problem during a different game -- he could count and add but not always recognize the numbers. Without assistance, he transferred the same counting strategy he used at the "Zoo" and got the answers correct. Later, he had no trouble using this strategy again. Each time he was correct he clapped and smiled. He was one happy boy by the end of his 1/2 hour, uninterrupted computer use time.*

While there is little solid evidence that the student has learned more about reading or writing, there is the perception that he was engaging in activities through which he experienced success and pleasure. These episodes are especially important to students whose self-esteem can become damaged as their experiences of failure mount.

Some of our teachers, however, were able to articulate a perceived connection between increased self-confidence and improved writing. In discussing the relation between self-confidence and good writing and how she felt the computer had enhanced this in some of her

students, one teacher explained that:

> *I think probably the biggest thing is that they will be able to feel more confident in their writing skills . . . because they will be able to write [with TTW]. When they're writing in their journals, when they're writing stories, they'll know how to associate some of the things they did. . . . If a child feels very confident . . . Like [a particular student]. I'm really trying to work on establishing a positive self-image, so when we had the "Toothbrush" on over here, he really caught on to that. So I made him the expert of that. He had to put the disks in for everybody . . . and he felt very good about it: "I'm in charge of this."*

One factor related to student success with ALS-EL is that, according to one teacher, *"it's not geared at one ability level"* and it *"adapts to all learning styles -- auditory and visual learners."*

Children learn in a variety of ways. Some find computers naturally conducive to their learning style; others must work harder at adapting. In the words of participating teachers:

> *I have [some] very slow children in here, and they can go over there and get the answer right on the computer, and when I ask them the same question in a lesson, they can't get it. That's amazing. I don't know how they do that.*

> *The writing, some of the children really take to and enjoy going and sitting and trying to type a story. And some of them, they can sit there all day and not type anything.*

Another factor related to student success with ALS-EL may be that the program appears to be non-threatening to students. One teacher noted that working with computers encourages students to experiment. In her words, *"The negative isn't hurtful."* She suggests that students feel comfortable trying out new things because the computer is saying, *"Go ahead, make a mistake, it's okay."* In the opinion of another teacher:

> *The children seem to accept [feedback from the computer] . . . better than the class hearing them make a mistake, or me telling them they've made a mistake. . . . And when they make a mistake, they'll go over it, correct it, and go on.*

Learning opportunities of this type can encourage "risk-taking" behavior that is an important aspect of learning. During her years of teaching, for example, one teacher has found it a challenge to design activities that meet the individual needs of her kindergarten students. This is a challenge for every teacher, but this particular teacher has an additional hurdle -- many of her students have recently immigrated to the United States and are not fluent in English. Using a variety of software, she has been able to tailor language arts activities for

each student. In her judgment, her students have benefited enormously from ALS-EL.

> *It has increased their confidence, allowing them to take more risks, which is a cycle that goes around and around. And the more they're willing to take risks, [the more] they increase language development and awareness of language use.*

Higher implementing teachers are more likely to cite self-esteem and/or self-confidence as positive outcomes of using ALS-EL than are those with lower implementation levels. This is not surprising since the research on implementation would suggest that teachers who are in the early stages of integrating an innovation into the classroom are more concerned with informational, personal, and management issues than with outcomes -- particularly ones that are as complex as self-esteem and self-confidence. While there are also some lower level implementers who provide evidence of the relationship of ALS-EL/computer use to self-esteem or self-confidence, we have no way of knowing if the relationship will be strengthened as teachers more fully implement the program.

Motivational Value of ALS-EL

The motivational role ALS-EL can play is also cited by teachers, particularly medium-high and high implementers, as an important aspect of the program. Obviously, it is difficult to clearly differentiate between motivational aspects of ALS-EL and the opportunities it provides for student success. Yet for purposes of discussion and further research, it is important to separate (even if somewhat arbitrarily) the motivational aspects of ALS-EL from the opportunities it provides for success.

A number of teachers participating in our study, particularly those who are high or medium-high implementers (and even those who are medium-low implementers) cite the motivational characteristics of ALS-EL as a valuable aspect of the program. According to one teacher,

> *They [her students] are well focused and engaged while at the computers, especially at the Talking Text Writer (TTW). They never give up any of their scheduled time and the student on the TTW often stays on it after he/she is supposed to return to seatwork or go to lunch.*

The number of different types of software included in the ALS-EL package appears to increase the motivational value of ALS-EL, particularly when one considers that student interest and skills will invariably differ. A broad array of software components allows teachers to tap into different student interests and sources of motivation (and success). In discussing ColorMe, for example, one teacher indicated that:

They do very little writing with it [ColorMe]. And I don't encourage them to use it for writing only because it's not a very practical vehicle for writing, because there is so little text that fits on a page. And so I haven't worried about that too much. You know, I do want them to write a little, but they're just writing more bulk now than ColorMe can easily accommodate. . . . The common thread is that they really like making designs with it, either pictures or abstracts, and they like the feeling of command over the software that they get from it.

Other components, such as the Talking Text Writer, are seen as motivational tools to increase students' interest in writing. The sound on the Talking Text is one unique aspect of the component that has particular motivational appeal. In the Muppet programs, songs and moving figures are often equally attractive motivators for younger students.

In discussing the Talking Text Writer, one teacher suggested that the printer plays an important role in providing children with something tangible to share.

I did this. It's mine. Then they can read it, share it with their families. . . . Being able to read it at home means a lot to them, they could show off how they read . . . Because they feel good about it, they continually want to do it and the more you do it, the better you get.

Our student interviews indicate an enthusiasm for the use of computers and a general acceptance of them as a regular part of the classroom. Using the computers is generally considered fun, and many students like using the computer more than using a pencil for writing. Students also like listening to the audio component of the Talking Text Writer. The following student comments highlight the views of participating children:

I like to write because it's fun. The funnest part is when you can hear the words being sounded out. I love writing on the computer.

I like the computer better because with a pencil, when you want to erase you have to push down kind of hard, but with the computer you just push "delete."

I like to watch the monkeys dance. I press the "M" and the "Control" and then the green one.

A number of teachers consider the computers and the software components sources of motivation for increased writing and/or reading (as well as increased knowledge about computers in general in some classrooms). According to one teacher:

It's been a huge incentive for some children to learn to read and write. . . . A supplement and another way of hooking them in.

The fact that students' writing can be printed like a book is also a source of motivation for students and teachers alike.

Not all teachers are equally enthusiastic about the motivational value of ALS-EL, however. One medium implementing teacher suggested that:

I know some of the slower children would rather go to the computers, because then they don't have to do their other work. They don't have to have the basic skills -- just punch a button. In that way, the computer is a hindrance to developing good thinking students.

A colleague who was a low implementer agreed.

The motivation was both bad and good. It was good because they all wanted to get on the computer and so they would work hard to be allowed a turn at the computer. However, sometimes they rushed through their seatwork and did not do a very good job on it because they were so anxious to get to the computer.

For most teachers, however, the positive motivational aspects of computers and the ALS-EL software components clearly outweigh any potential negative features.

Cooperative Learning Behaviors

When used appropriately, computers can offer students new and exciting opportunities to work together cooperatively. The new behaviors and attitudes students may acquire as a result of such cooperative learning experiences may have an impact on student achievement. Assessing the relationship between such cooperative behaviors and attitudes and writing outcomes -- or any other student achievement outcomes -- was well beyond the scope of this project. However, we were interested in identifying ways that computers in general and ALS-EL in particular, can facilitate various cooperative behaviors, given the positive value that educators and researchers place on this type of behavior.

Some teachers in our study have consciously used the computers as an opportunity to foster cooperation among students, peer tutoring, and general cooperative learning. We found that 35 percent of teachers participating in the study frequently pair specific students to enhance their learning experience; 51 percent encourage students to work in pairs, but do not often pair specific students; and 14 percent do not actively encourage (and may even discourage) working in pairs. All the teachers in our two highest implementing sites encourage students

to work in pairs.

The methods and reasons for pairing students differ among teachers, however. In some instances, teachers pair students on the computer because the students are of different abilities, sometimes because they are friends, sometimes because they share the same native language, sometimes for the sake of promoting cooperation and sharing, sometimes for the sake of efficiency -- moving more students through the stations in less time, etc. In other cases, as suggested above, the configuration of the computers themselves promotes cooperation among students.

Teachers were able to cite many examples of students assisting other students throughout their use of the computers. Sometimes the helpers were one of a pair; other times they were "accessible" when help was needed; and in still other instances, particular students were considered the computer "experts" and played such a role in providing assistance. In most sites, our observations confirmed these teacher reports of students helping students and working cooperatively.

Even in classes where teachers have not attempted to pair students or encourage cooperative behavior, it is not unusual to observe one student peeking at another's screen and offering assistance, praise, or criticism, nor is it uncommon to find examples of students seeking out the naturally emerging technology experts among their fellows for advice and help.

Negotiating "sharing" the computer was a common occurrence in many classes. In one class, for example, we observed a pair of students begin their session by negotiating which exercises within the Muppet Word Book they were going to use and establishing ground rules on taking turns. In this observation, one student decided because he was better at moving the cursor that this would be his primary job; she would decide what they wanted to write and he would help her move the cursor, find letters, etc.

Tentative Conclusions Regarding Student Non-Literacy Outcomes

In explaining her reasons for using the Talking Text Writer, one participating teacher summed up many of the benefits to students discussed above:

> *Because it is highly motivational. It also promotes lots of social interaction and verbal exchange with their peers. Social learning is very important. The kids share so much with each other whether it be learning the keyboard, helping each other with writing, or whatever it may be, and it takes the instruction away from the teacher and the kids become peer tutors. It really works great! And of course it promotes more*

reading and writing. . . . Their attitudes have improved, they have become risk-takers; this program gets them to become risk-takers in reading and writing. They are very positive about the computer. They are learning that they can become risk-takers, and build their self-confidence. They know that the computers are not going to "buzz" them, they don't have to have a perfect response and they know that it's flexible, so they feel much more confident about what they are doing.

This teacher is not alone in her belief that ALS-EL, with its use of computers and multiple software components, can promote a range of non-literacy development student outcomes that are highly valued by teachers, researchers, and parents.

In analyzing our observations, anecdotal reports from teachers, student interviews, and parent perceptions, we found several emerging patterns and trends:

- ALS-EL provides students with alternative avenues for success, both personally and with peers, which may lead to increased self-esteem and self-confidence; this may be a particularly effective strategy to employ with students traditionally considered at risk of school failure.

- ALS-EL can be highly motivational for students and can therefore play an important role in enhancing students' interest in learning.

- ALS-EL provides students with opportunities to work together cooperatively and to tutor and/or assist one another.

We also saw some evidence that ALS-EL provides students with non-threatening learning experiences that can encourage experimentation and risk-taking.

We are only at the first stage of exploring and understanding both literacy and non-literacy outcomes, however. Without a longer term study, it is impossible to even state definitively that these are lasting outcomes. Teachers' perceptions of the impact on literacy development may change, benefits may decrease or increase. What serves as a motivator for students today may become boring or a disincentive tomorrow.

We are confident, however, that the teacher is the key to successful use of computers and ALS-EL. ALS-EL is a reinforcer or catalyst for literacy development, a motivational tool, and a facilitator of cooperative behavior only in so far as the individual teacher makes intelligent use of what the program offers. Its strength lies in its ability to increase the repertoire of the teacher and allow him or her to be increasingly effective in the classroom.

ALS-EL and Teacher Change

We had hoped that by observing children as they used ALS-EL or did other work on computers, teachers would begin to view students in a new light. We had hoped that teachers might, for example: (a) gain more individualized knowledge of the skills and needs of individual students; (b) be more aware of the different kinds of intelligence or non-academic strengths that students may have; (c) consider different views about the learning process (e.g., that children can learn from opportunities to explore and create and solve problems on their own, or that children can "write" before they've been "taught" all the letters). We found relatively little evidence to support that teacher attitudes and beliefs about student learning were substantially altered by the introduction of ALS-EL. Nevertheless, we did find some noteworthy exceptions that we discuss below. Furthermore, we consider this far from a closed issue given that this was only the first full year of implementation; modifying one's attitudes and beliefs is a long-term, sophisticated venture that realistically we could not expect to occur over such a short period of time.

Increase in Peer Tutoring or Cooperative Learning Activities

One change in the learning environment facilitated by ALS-EL has been the creation of more cooperative learning opportunities, as indicated above. Our observations and discussions with teachers showed that there was a great deal of peer tutoring and cooperative learning going on in the majority of project classrooms. In fact, the physical layout of the computer center in many of the classrooms included two chairs at each computer as part of its ongoing configuration. One administrator in a school that has traditionally emphasized teacher-directed, whole-class instruction, indicated that she hoped the computers would pave the way for cooperative learning in her school:

> *Because with the centers, where the children are working two at a computer -- I like the idea of two, because with two children, they not only interact with the machine, they interact with each other, and it's a mini-cooperative learning going on, and they have an opportunity to communicate. . . . The one thing that disturbs me greatly is that far too many teachers consider the communication almost one-way. Teachers talk all the time, but children have to stay quiet and write. And these children need to communicate; they need to think, they need to talk to each other, [and] talk to the teacher. Too many teachers require one-word answers. It's particularly true, unfortunately, in many classrooms . . . these children need more communication skills, because maybe they've been deprived of some of that in the home setting or in the community. The environment is not as enriched, and then when they come to school, we compound it by telling them to -- "Sit still, work on your paper, don't talk to anybody, don't get out of your seat until I tell you." And I think that we have to open up. . . . [I hope] these [computer] centers, in a*

sense, will help some teachers to see that it does work.

In other sites, students in most classrooms worked cooperatively at many activities in addition to their work at the computers. Some teachers reported that the computers provided a new way for students to work together. For example, one teacher established a "buddy system" in her first grade class that encouraged her students to learn from each other. She stated, *"I'm not the only one who can answer their questions."* When students had questions about the computer (and other topics), they asked their buddies before asking the teacher. The buddy system fostered self-confidence.

In one school, all participating teachers believed that the computers had increased the amount of peer tutoring activities. *"Kids are working in pairs, peer teaching; computers have promoted this, at least at the computers."* Yet even in a school site with only three ALS-EL classrooms, this peer teaching occurred in a variety of forms. In one class where student use was planned primarily during center time, the teacher rotated a group of four to six children on the three computers every 20 minutes. During each 20 minute period, the group of children worked independently, in pairs or small groups, and the peer teaching happened informally. For example, a girl showed a boy how to turn up the volume on the earphones. In another class, children were scheduled on the computers individually and sometimes in pairs for a particular activity like typing in a dialogue together. In this class, we observed two children working together when one made a mistake and didn't know how to fix it. While he went for the teacher, the other student figured out how to erase or delete, and she showed him when he returned. Since the computers were near one another, peer teaching could still occur when students were scheduled individually. In the third classroom, students were scheduled on the computers in English dominant - Spanish dominant pairs to facilitate bilingual peer tutoring at the computers. For example, one boy showed another how to change Muppetville activities, while giving instructions in Spanish.

At the computer, teachers often made a concerted effort for students of differing abilities to work together. *"I'll let some of the more advanced kids work with kids who need more help,"* said one kindergarten teacher.

Our classroom observations pointed out a variety of ways in which teachers paired stronger and weaker students. For example, in our early childhood class, the teacher often paired more experienced, older students with younger students. We observed a five year old helping a three year old through one of the Muppet programs. In other classes, we observed English proficient students working with LEP students on various ALS-EL programs. In several sites, we witnessed examples of cross-grade tutoring, where students in upper grades worked with students in the project classes.

In a site where we observed kindergarten through grade five Chapter 1 pullout programs,

older students served as tutors for younger ones with cognitive and affective benefits for both groups.

One administrator pointed out:

> *Another benefit of that program [Talking Text Writer] is that it puts print up on the screen and then you can have kids sitting around it, so it's kind of like a mini-conference where kids are conferencing with each other about the screen.*

According to a teacher at the same site, which has a highly transient, low-income population:

> *Just the fact that the kids are able to get along better when they're using the Muppets. And the problem-solving, how to deal with things that may come up, how to cooperate with each other . . . a lot of times it's just "Did anybody figure out the power strip wasn't on?" Or "We're at the menu, and how are we going to get to the next program?" They're helping each other learn how to deal with the software.*

In at least one class, the only evidence of cooperative learning we saw in the classroom was at the computer; all other class activity appeared to be whole-class and teacher-directed.

In the most traditional site we observed, students in one first grade classroom went to the computers in pairs but were expected to take turns and watch each other rather than complete activities cooperatively (although the teacher allowed some cooperative work in completing seatwork). In a kindergarten classroom at that site, students went to the cloakroom next door to work in pairs at the computers, which was the only opportunity for student-student interaction observed in this class. These kindergarten students, however were inexperienced at working cooperatively and were unable to do so.

Only two teachers, both low implementers, indicated that they actively discouraged students from working together at the computers. In each case, the teacher felt that it caused a behavioral disruption for the rest of the class. In one of these classes, the teacher allowed little or no cooperative learning activities in any part of her classroom. In the other class, the small physical size of the classroom made any noise quite obvious throughout the rest of the room.

Increased Flexibility of Instructional Environment

For the most part, teachers were making relatively few changes in their overall teaching approaches in order to use ALS-EL. ALS-EL fit easily within the routine schedule of classrooms where independent learning centers, small group activities, and individualized

instruction were already common. In these classrooms, ALS-EL represented an additional learning center rather than an entirely new concept. The teachers could incorporate computers into their repertoire without having to make major changes in their standard operating procedures or the overall classroom structure. *"Planning [for computer use] is not a big issue because it fits in with the total curriculum,"* said one teacher. In this site, teachers and students used ALS-EL often and in an impressive variety of whole-class, small-group, and individualized activities; however, we feel sure they would be involved in an impressive variety of whole-class, small-group, and individualized activities even without the program.

Yet, in classrooms where whole-class, teacher-directed instruction was the norm, the mere introduction of a computer station or center represented a major change to the overall instructional structure: the concept of children working independently was new to these classrooms, as was the concept of working in centers. Teachers in these classrooms had to make several major instructional shifts that didn't explicitly involve computers (e.g., independent work by students, learning centers) in order to accommodate or introduce computer use, and some found the totality exhausting. As one teacher said:

> *I can't be doing two to three things at once. Sometimes I can manage three, but not very often. When you have reading group and managing computers and trying to keep my eye on both, and teach at the same time, I think that's just about all I can do, you know?*

The physical environment in every classroom changed with the introduction of ALS-EL. In most classrooms, the three computers and printer were clustered together, creating a new work space or center. However, in some classrooms, the addition of the new learning center was a change in number rather than kind; focused work spaces or centers existed in these classrooms even prior to the introduction of ALS-EL. The traditional physical setting changed more radically with the addition of a computer work space. Here, the creation of a work space other than rows of desks and a reading table was a major change.

Other aspects of the physical environment changed as well in some classrooms. In some classrooms, much of the environmental print was computer-generated; student work was displayed on the walls, along with computer-generated class lists and instructions. One teacher said, *"It's really important that we can produce big print on the screen and on paper."* Much of the work that these teachers had been doing on wall charts or poster board was now done on the computer, and as a result, individual copies of group work could go home with students more frequently.

In addition, some teachers reported an excitement and activity level that made the classroom more pleasant. One teacher, who scheduled her students for computer use every other day, but made it available as a highly popular option during daily free choice time as well, noted that *"Some kids die if they can't use it every day. They probably make deals with the other*

kids [to get a turn]." And, according to another teacher, *"It's much nicer with the computers here."*

However, there were some exceptions to this view. Several teachers who had physically small, noisy classrooms limited the use of computers, because they felt they were distracting for the rest of the class. These teachers, plus some teachers who had very traditional approaches to classroom management and instruction, preferred that computers be offered to students as a pull-out, out-of-classroom experience.

In classrooms taught by teachers with more traditional approaches to classroom management and instruction, the children's independent or peer group work on computers represented very different kinds of activity than the traditional, whole-class, teacher-directed instruction that the teachers customarily provided, even though these teachers tended to be low implementers. What might seem to be relatively modest computer use in these classrooms may actually indicate more substantial changes to the instructional process. Some low implementers used only the more closed-ended software packages (such as the Muppets and Sound Ideas) in regularly scheduled but not well supervised sessions on the computer. Nevertheless, in these classrooms, the introduction of ALS-EL could possibly lead to more profound changes over time by "unfreezing" traditional patterns of instruction.

Within the limited time frame of our study, we did not observe parallel changes in the flexibility of noncomputer-based instructional activities. The creation of a computer center did not lead to the creation of a math or science center, for example, nor did independent work at the computer lead to other independent activities. One administrator believes *"the greatest barriers to change are attitudes -- resistance to change"* among educators. She hoped the computer centers would help stimulate new instructional practices in her school, where most teachers were still following a very traditional approach to classroom management and design:

> *In many traditional classrooms, teachers tend to teach to a total group or to half a group at a time. And there are . . . [few] opportunities for children to actually develop at their own pace. They have to move lockstep with the group. . . . Using the program's materials on the computer . . . once a kid knows how to operate it, you can give them the program. So the teacher, then, takes on a different role. It's not just what I dictate, and everybody has to do it. I can allow the three children over here on computers work at their own pace. When they're done, they can then move back into the total group; three more can move out. And I think it will change a lot.*

Under certain conditions, then, ALS-EL enhanced the flexibility of the instructional environment and opened up the classroom in different ways. In classrooms where there was already a great deal of flexibility, teachers credited the computers with helping them to open

up the classrooms even more. Where thematic learning centers were already a part of the instructional design, ALS-EL provided a center with a different focus, allowing for new kinds of independent, small-group, and whole-class learning activities. As one administrator said,

> *It's a place where they [students] can express themselves about the things they've been doing, whether it's science or social studies or just their own thought or what they've read in literature. So I think it's opening up the classroom; it's a part of it, just like another table where they sit and do something; it's not shoved off someplace; they don't have to walk out of the room to get to it. . . . I think the teacher just has to take charge of it and use that computer like the chalkboard.*

However, where ALS-EL was the only independent learning center, its successful use required more dramatic changes in classroom design and instructional practices. There were more hurdles to jump or barriers to break down in these classrooms than in classrooms where centers were already commonplace. As mentioned above, some teachers said they would prefer having computers outside the classroom, if they are used at all.

Increase in Writing Activities

In each site, some teachers reported an increase in writing activities in their classrooms and credited the computers with playing a role in the increase. Selected teachers reported that children were spending more time with writing, and writing more stories, longer stories, more creative stories. Also, they used the computers to produce class books, daily news, end of day "wrap-ups," and to work with vocabulary and spelling lists.

Unfortunately, however, the evidence was quite mixed, both within and across sites. Our two highest implementing sites were the most likely to provide evidence of increased writing. Similarly, within sites, lower implementers tended to provide less evidence of ALS-EL resulting in more writing activities. Nevertheless, according to one administrator, *"I know they have really gotten into reading and writing."* The administrator in a school with relatively low implementation hoped the computers would be a catalyst for change in her school:

> *I have some keen concerns about the level of writing, the amount of writing that we do. I felt that somehow we're missing the boat, and I do see the computer as one means of helping us to bridge some of the gaps -- to shore up some of the weaknesses there.*

She went on to describe a teacher who was initially resistant to the project and had misgivings as to its value or children's ability to use the computers. This teacher came into her office Monday morning after a weekend workshop with a handful of student printouts, the

first to try Where Did My Toothbrush Go? in her class: *"Look, they actually did it!"*

Viewing Student Learning in a New Light

We were disappointed in the limited evidence we found that teachers came to view student learning in a new light as a result of the implementation of ALS-EL. Nevertheless, we heard strong administrator support in some of our sites for the hope that computers would enable teachers to view students in a new light. According to an administrator in a school where whole-class instruction was the norm and where a reading group of 10 or 15 was likely to be the smallest instructional unit a student would experience:

> *I think when they [teachers] interact with children independently at the computers -- because the teacher there serves as a facilitator or monitor as the child is working -- they see the children in a different light, as opposed to how you see the child when he or she is there in a reading group of 10 or 15. So I think we're going to see some changes there.*

An administrator at a school where students had more small group and individualized instruction opportunities, agreed:

> *The reading and the writing will come because of what teachers are seeing kids able to do with the technology. . . . I think more than anything, who was it who said, it's a "window on kids' thinking," and I really feel that if you sit back and watch the kids operating, you really can see the process that kids are going through.*

By the end of one year of implementation, some of these administrators' goals were beginning to be touched, although only to a limited extent. In some instances this can perhaps be accounted for because of the level of implementation; higher implementers appeared to be more likely to evidence at least some minor change in behaviors and attitudes than were low implementers. In addition, in some of our sites, participating teachers already had what might be considered "enlightened" views of student learning. In still other cases, more narrow views of learning make such change difficult, particularly during such a short period of time; attitudes take substantial time to change.

We did find evidence that some of the teachers we observed believed that computer use helped them learn more about their students. Kindergarten teachers, particularly, credited the computers with helping them to enhance their understanding of their students. According to one, *"You really get another way of looking at kids when you see them at the computer."* Another kindergarten teacher liked the *"record of progress"* she felt was possible with Talking Text Writer, and wished Sound Ideas had a similar, cumulative record feature. Kindergarten teachers in four of the six sites believed that the computers helped them in

assessing student needs or gaining new information about children's learning.

Consider, for example, the following illustration:

> *In one kindergarten classroom, the highlight of the day for many children is working at the computer center, an identified workspace with three computers and a printer. During center time, [the teacher] always works at the computer center, guiding her students through their activities. Typically, she meets with one student while other students work independently at the computers or a nearby table.*
>
> *For [the teacher], this one-on-one approach has a major benefit: "I get to watch children more. I know them better by watching them at the computer." [The teacher] points out that computers encourage students to experiment. And she adds, "Hopefully, I'll be able to be with them when they're ready to make that next step, whatever it may be."*

Most of the teachers who indicated that the computers helped them gain insight into how and what their students were learning were medium to high ALS-EL implementers operating within skills or whole language orientations. Only one low implementing teacher (in the skills-whole language range) supported the proposition with her belief that the computers helped her to *"evaluate and observe"* her students.

In several cases, field researchers concluded that, prior to implementing ALS-EL, teachers were keenly aware and capable of assessing their students' strengths and needs, and that the computers provided relatively little additional information. In a few cases, teachers appeared "burned-out" and not interested or able to process possible information about their students from their computer use. Their assessment of student capabilities remained relatively low throughout the year.

Tentative Conclusions about ALS-EL and Classroom-Teacher Change

While the very presence of the ALS-EL configuration added to a classroom required an obvious physical change, the extent of the actual change in the overall instructional environment varied widely. In the majority of project classrooms, cooperative learning activities at the small group level appeared to increase. Teamwork at the computer was generally encouraged. While some of these teams were random, in many cases teachers made conscious pairing choices to enhance peer teaching-learning partnerships.

ALS-EL appeared to fit most readily into classrooms that were already operating with a centers-based approach, although this approach alone did not guarantee a ready fit. The addition of a new center -- the computer center -- created a difference in numbers, not

necessarily kinds, of instructional transactions. In a traditional classroom focusing on whole-class instruction, however, the introduction of ALS-EL could indicate a more profound change in the overall instructional environment by "unfreezing" more rigid patterns.

In each of the sites our study explored, ALS-EL served at least somewhat as a catalyst for change, although the changes were different in each site, and in some cases, varied across classrooms within a site. Teacher attitudes and openness to change appeared to affect the extent to which the computers were used, and the extent to which they could serve as a catalyst for change. Meeting teachers' needs would appear, then, to be a critical issue in assuring successful implementation of an innovation such as ALS-EL if it is to meet its potential.

Conclusion

It is difficult, if not impossible, to separate the impact of ALS-EL from the effectiveness of the teacher using it. It is also unrealistic to expect to see measurable changes, particularly in student achievement, in the first year of implementing something as complex as ALS-EL.

Given these cautions, our qualitative analyses, relying on classroom observations, teacher surveys, and teacher interviews, suggest that ALS-EL was having some impact on student literacy and non-literacy outcomes. We heard the following major points from some participating teachers with respect to the impact of ALS-EL on students' literacy development:

- ALS-EL serves to reinforce student achievement in the language arts;
- ALS-EL (especially Talking Text Writer) has positive impact on students' writing; and
- ALS-EL contributes to the development of important computer competencies.

We and a number of our participating teachers agreed that the first year of implementation was too soon to make definitive statements regarding literacy outcomes -- and that it was nearly impossible to separate ALS-EL from other aspects of the language arts program and the instructional effectiveness of the teacher.

We are similarly cautious in our findings concerning non-literacy student outcomes. We did see evidence to suggest the following:

- ALS-EL can provide students with alternative avenues for success that may

lead to increased self-esteem and self-confidence;

- ALS-EL can be highly motivational for students and can therefore play an important role in enhancing students' interest in learning; and

- ALS-EL can provide students with opportunities to work together cooperatively and to tutor and/or assist one another, thereby developing cooperative learning behaviors and attitudes.

In terms of classroom and teacher change, we found that the learning environment was positively affected by the introduction of ALS-EL in two important ways. First, in a number of classrooms, there appeared to be an increase in the number, frequency, and/or kinds of peer tutoring and cooperative learning activities that teachers fostered or allowed. Second, particularly in centers-based classrooms, ALS-EL offered new opportunities for students to work together independently or in small groups, take initiative, make choices, move around the classroom or talk with peers, work at their own pace, and/or express themselves creatively.

Overall, we found that ALS-EL can function as a catalyst for change, contributing to the transformation of the learning environment. While its flexibility enables it to be adapted to individual teacher instructional and management styles, certain of its features (e.g., that it requires the creation of a type of learning center) also lead necessarily to changes in the classroom. However, the role of these changes in transforming instructional practices is not conclusive from our study. We believe we found more evidence that traditional practices constrain the use of ALS-EL than proof of the power of technology to transform traditional practices. We believe (along with others who have looked at this issue) that technology can be used to support a school improvement vision; but technology alone will not transform schools. The vision must be supported by teachers as well as by all the features of the organizational system for education.

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